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The use of 'Precision Teaching' in enhancing medical students' dermatological diagnostic skills

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Abstract

Background

Educators have been challenged to provide more effective dermatology teaching methods. Drawing from the discipline of Applied Behaviour Analysis, Precision Training (PT) (e.g. using flashcards during timed learning sessions) can promote fluency i.e. *accuracy* and *speed* in a particular skill. We aimed to determine the impact of PT on medical students' dermatology diagnostic skills.

Methods

A between-groups controlled interventional study was conducted. Third year medical students were allocated to an intervention *(PT + traditional teaching)* or control *(traditional teaching)* group. For the PT group, we designed 50 dermatological image flashcards. Flashcard practice *(using the Say All Fast Minute Each Day Shuffle method)* took place 2-3 times/day and students' data on accuracy recorded over 5 days. Pre / post-training tests were carried out to determine the impact of PT on students' diagnostic skills.

Results

In total, 70 students (intervention group) / 65 (control group). Analysis of covariance was used to calculate the change score (comparing pre- and post-test). A statistically significant improvement of 8.8% (95% CIs; 4.9-12.7, $p<0.001$) was detected in the intervention group.

Conclusions

The findings of this study demonstrated a positive effect of PT on medical students' dermatology diagnostic skills. This study signals new pedagogical opportunities for PT in undergraduate dermatology teaching.

Keywords: medical education, precision teaching, behaviour analysis, dermatology diagnostic skills

Introduction

Challenges in undergraduate dermatology education

Dermatological conditions are a common reason for patients to present to their general practitioner (Schofield, Fleming, Grindlay, & Williams, 2011), therefore adequate grounding in dermatology is fundamental for a wide range of doctors. However, dermatology is often

under-represented in medical curricula, with medical students frequently lacking skills and resulting confidence in assessing and diagnosing dermatological conditions (Chiang, Tan, Chiang, Burge, Griffiths, & Verbov, 2011; Yaakub, Cohen, Singh, & Goulding, 2017). In response, the British Association of Dermatologists (BAD) have proposed a dermatology curriculum that aims to enhance the awareness, teaching, and learning of dermatology in UK medical schools (British Association of Dermatologists, 2016). However, of the many challenges of implementing such new proposals, competing for adequate curricular space poses a significant barrier. Compounded by the challenges in health service delivery, never more has there been a need to develop new approaches in dermatological teaching.

Dermatology is very much, but not exclusively, a visual-based speciality that is traditionally taught in a blended approach, i.e. a mixture of classroom based lectures, online learning materials and where possible outpatient clinic attendance. Students use both pattern recognition and analytical processes learning dermatology (Burge, 2004). Development of pattern recognition requires repetition (Sneddon, 1970) however there are increasing challenges of providing sufficient real-patient learning experiences for medical students. For example, it has been reported that over 80% of medical students have never seen a patient with malignant melanoma skin lesion during their undergraduate training (Aldridge, Maxwell, & Rees, 2012; Gormley, Menary, Layard, Hart, & McCourt, 2013). Such patients require prompt management on detection therefore presenting them to a large group of students would be inappropriate. For this and other reasons, the use of clinical images is core to the acquisition of dermatological skills. Such teaching is typically delivered in didactic formats that focus on the description and diagnosis of dermatological conditions. Despite these established teaching methods, students often remain underprepared when they meet patients with dermatological problems (Chiang, Tan, Chiang, Burge, Griffiths, & Verbov, 2011). Thus, dermatology educators are challenged to augment traditional teaching methods in order to improve learning efficiency without overburdening already limited educator resources.

Precision teaching: *A new approach for dermatology education?*

Dermatology experts use intuitive or non-analytical skills such as pattern recognition in clinical reasoning more than novices – this allows for more rapid and accurate diagnosis with lower cognitive load than analytical processes (Krupinski, Chao, Hofmann-Wellenhof, Morrison, & Curiel-Lewandrowski, 2014). The brevity of dermatology clinical placements has often been viewed as a barrier for students to learn non-analytical/pattern recognition skills (Burge, 2004) with greater emphasis placed on the teaching and development of analytical skills. Innovative teaching techniques demonstrate that pattern recognition can be taught and that relatively brief interventions can produce large learning gains (Kellman, 2013).

Developed from the scientific discipline of Applied Behaviour Analysis (ABA), *Precision Teaching* (PT) is an educational method that has been used to develop behavioural *fluency*, i.e. *accuracy* and *speed* in performing a particular skill efficiently (Lindsley, 1992). PT has been used in a range of educational contexts including mainstream primary education and special needs education, for example with individuals with autism (Kubina, Morrison, & Lee, 2002). PT uses frequent, brief timed measures of student performance on specific learning points with the aim of monitoring changes in accuracy and speed of student performance, which aids generalisation, retention, endurance, stability and application of knowledge and skills into real life settings (Binder, Haughton, & Van Eyk, 1990). *Behavioural fluency* differs from *mastery* of skills in that, whilst *mastery* aims to enhance levels of *accuracy*, *fluency* also considers the *pace of performance*. There is growing interest in PT in health professional education (Lydon, et al., 2017).

There are a number of specific teaching methods used in PT. One such method involves the use of ‘flashcards’ containing the question or discriminative stimulus on one side and the correct answer or target behaviour on the reverse (Lindsley, 1992; Potts, Eshleman, Cooper, & Ogden, 1993). Incorporating a time component to this learning method is important to developing accuracy and speed. Say All Fast Minute Each Day Shuffle (SAFMEDS) is one such method that aims to increase fluency (Beverley, Hughes, Hastings, 2009; Lindsley, 1992; Potts, Eshleman, Cooper, & Ogden, 1993). In SAFMEDS a timer is set for one minute and the learner reads the question on one side of the flash card and provides an answer as quickly as possible. The reverse of the flash card is then checked for correct response and the card placed either on the ‘correct’ or the ‘incorrect’ pile. This process is repeated through the pack of flashcards for one minute until the timer goes off. The number of correct and incorrect responses is recorded by the student. The deck of flashcards then is shuffled and the process repeated later that day or the next day, offering a new ‘learning opportunity’, with the learner aiming to improve their previous score in terms of increasing correct target behaviours and decreasing errors.

In this study, we hypothesised that PT may be useful for the development of medical students’ dermatological diagnostic and descriptive skills.

STUDY AIM

We aimed to determine the impact of PT on medical students’ dermatological diagnostic skills, using a between-groups controlled interventional study.

Method

Ethical approval

Ethical approval was given by the School of Medical, Dentistry and Biomedical Sciences' Research Ethic Committee, Queen's University Belfast (QUB) (Ref: 15.31).

Setting and context

The study took place in QUB during the academic year 2015-16. The medical degree programme at QUB follows a 5-year integrated undergraduate curricular model, with formal dermatology teaching taking place in the third year of studies. In this one-week module, students attend a series of introductory lectures, tutorials and out-patient clinics supplemented by online lectures. The module is repeated 12 times in one academic year with approximately 22 students randomly allocated to each delivery.

Recruitment and sampling

In order to provide 80% power in detecting a significant difference between the 2 groups a sample size of at least 50 in both the *intervention* and *control* groups was required.

Prior to starting their dermatology module, medical students (n=263) were invited by email to participate in the study. Students had already been randomly allocated to one of the 12 dermatology teaching modules throughout the academic year. Each module grouping that contained consenting participants was randomly allocated to either an *intervention* (i.e. traditional teaching plus precision teaching*)* or a *control* (i.e. traditional teaching only) group. Students not consenting to participating in the study received the same teaching as the control group (i.e. receiving the usual dermatology course).

Participants in both groups were asked to complete a questionnaire that captured their basic demographic details on their first day of their dermatology module.

Intervention group

Participants in the intervention group were asked to complete a timed-base dermatological diagnostic test. This test was composed of 30 picture based dermatological description and diagnostic questions. Question topics in this test were systematically sampled from the BAD recommended undergraduate medical student dermatology curriculum (British Association of Dermatologists, 2016). Participants were not provided with the correct answers after carrying out the test.

Participants then attended a briefing session about the use of the dermatology flashcards and the SAFMEDS teaching method. Each student was provided with a pack of 50 dermatology based flashcards (Figure 1). The images used in these flashcards were also based on the BAD undergraduate medical curriculum recommendation but differed from the images used in both the pre- and post- dermatology diagnostic tests.

Figure 1. Image of dermatology flash cards with image on one side and correct diagnosis on the other

Subjects were briefed in how to use the SAFMEDS flashcards (Haughton, 1980). They had to read the question on the top side of the flashcard and attempt to provide the correct answer provided on the reverse of the flashcard as quickly as possible, for one minute in each trial (Figure 2).

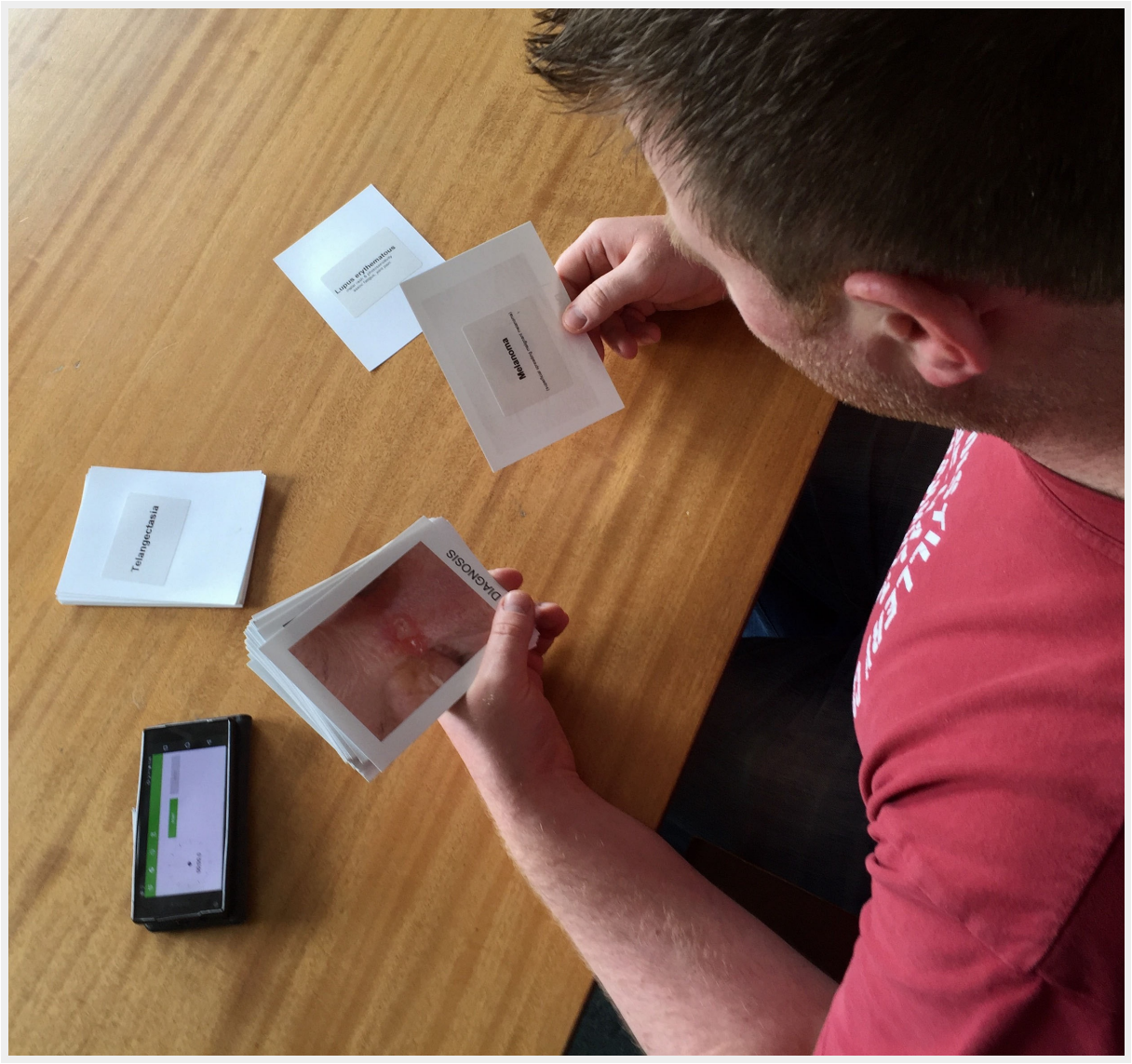


Figure 2. Illustration of a student applying the SAFMEDs technique using dermatology flashcards.

The number of correct and incorrect responses was formally recorded in the designated datasheet (Appendix 1). In subsequent attempts the deck of flashcards was shuffled and the process repeated. Students were instructed to practice using the SAFMEDS at least twice a day (for one minute each time), averaging 10 sessions in total per week. Participants recorded the number of correct and incorrect responses they gave in each 1 minute SAFMEDS period on a data sheet. Participants were supervised during each precision teaching session and did not have access to the dermatology image cards outside these times. They also received the traditional teaching methods in this module.

On the last day of their dermatology module (i.e., on Day 5), participants completed the 30-question dermatology image based diagnostic test again; the questions were the same but they were shuffled. They were also invited to 1) provide free text comments about their experience of using the dermatology flash cards and the SAFMEDS teaching method and 2) indicate whether the use of SAFMEDS improved their confidence in dermatology diagnostic skills (i.e. Yes or No).

Control group

Participants assigned to the control group were asked to complete a questionnaire that captured their basic demographic details on the first day of their dermatology module. They also completed the same 30 question dermatology image based diagnostic test as the intervention group, at the beginning and end of the study period. They received the traditional teaching methods in this module but without the use of the dermatology flashcards. After the study was complete, they were offered an opportunity to access the dermatology flash cards and accompanying instructions outlining the SAFMEDS method.

Analysis

The primary outcome measure for this study was the statistical intra-group difference between the pre- and post-training dermatological image-based test for the intervention and the control groups as well as the assessment of inter-group differences. Analysis of Covariance was used to calculate the change score (i.e. post-test scores as a function of pre-test scores and assigned group) and the impact of the number of SAFMEDS attempt on the post test score. Thematic analysis was used to analyse free-text comments provided by participants from the intervention group.

Results

Participant demographics

Of the 263 students in the total year group, 134/263 (51.0%) consented to take part in the study. Table 1 outlines the demographic characteristics of the total year group, intervention and control groups in this study.

		Study groups	
	Total year group	**Intervention group**	**Control group**
Number (%)	263	70/134 (52.2%)	64/134 (47.8%)
Age (Years)			
• **< 25** • **≥25** • **Mean age**	223/263 (84.8%) 40/263 (15.2%) 22.6	64/70 (91.4%) 6/70 (8.6%) 21.7	59/64 (92.2%) 5/64 (7.8%) 21.8
Gender			
• **Female** • **Male**	145/263 (55.1%) 118/263 (44.9%)	49/70 (70.0%) 21/70 (30.0%)	43/64 (67.2%) 21/64 (32.8%)

Table 1. Demographic characteristics of total year group, intervention and control groups.

Performance in pre- and post- dermatology diagnostic test

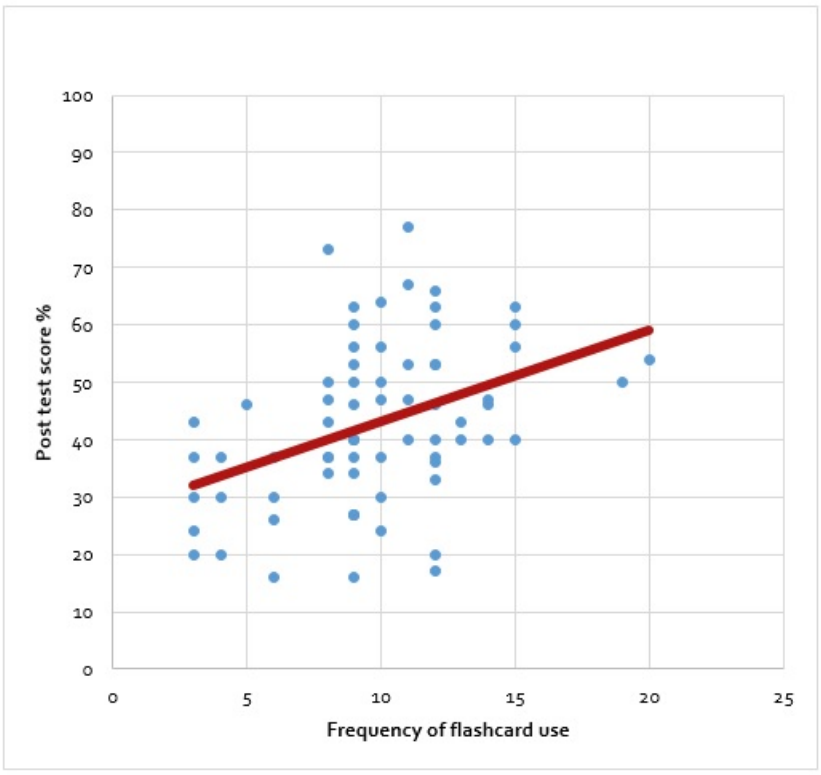
Table 2 outlines the performance in the pre- and post- dermatology diagnostic test for both the intervention and control groups. A statistically significant difference was detected in the post-test performance between the intervention and control groups 8.8%* (95% CIs 4.9-12.7) p<0.001 *(*score moderated by analysis of covariance due to differences in pre- test scores between intervention and control groups).*

	Intervention group	**Control group**
Pre-test performance mean % (range)	37.3 (3-77)	33.8 (13-67)
Post-test performance mean % (range)	79.9 (37-100)	69.7 (40-93)

Table 2. Performance in the pre- and post-dermatology diagnostic test for both intervention and control groups.

Impact of number of SAMFEDS trials on dermatology diagnostic test performance

Participants in the intervention group were encouraged to use the dermatology SAFMEDS flashcard for least two 1-minute trials per day over 5 days (expected total number of 10 trials). The total number of trials completed by participants ranged from 3 to 20 (mean 9.8 trials per participant). Analysis of covariance indicated that performance in the dermatology diagnostic test increased by an average of 1.6% per additional SAFMED trial (95% CIs 0.97 to 2.25) showing a 'dose effect', i.e. the more SAMFEDs trials correlated with an improved performance in the dermatology diagnostic test (Graph 1).



Graph 1. Correlation between number of overall dermatology SAFMED flashcard attempts and performance in dermatology diagnostic test.

Impact of gender and age on dermatology diagnostic test

The separate potential moderating effects of gender and age on the dermatology diagnostic test performance were examined. Neither gender (p=0.527) nor age (p=0.548) had any significant impact on post-test scores.

Free-text comments

Participants in the intervention group were asked to provide free-text comments on the use of the dermatology SAFMEDS flashcard teaching method. Thematic analysis of these comments yielded 4 main themes: 1) *'Drilling the message home'* 2) *'Just a minute'* 3) *'Enhanced confidence'* and 4) '*Bridging the practice/ theory gap?'*. A summary of these findings is provided in Table 3. Overall 68/70 (97.1%) of participants in the intervention group agreed that the use of SAFMEDS improved their perceived confidence in dermatology diagnostic skills.

Theme	Description	Exemplar quote(s)

'Drilling the message home'	The SAFMEDS teaching method enhanced learning through pattern recognition, reinforcement and repetition.	*"The flashcards were good for drilling in the descriptions and diagnoses."* *"Seeing images repeatedly helped."*
'Just a minute'	The brief interval of the SAFMEDS trials was considered to be an efficient use of learning time	*"Very useful especially the short burst technique."* *"…having to work within the timed minute meant you got through lots of flashcards during the week than you would have on your own."*
'Enhanced confidence'	Overall the dermatology SAFMEDS teaching method enhanced learner's perceived confidence.	*"I really improved at recognising conditions quickly."* *"Recognised more and felt more confident each time I used flashcards."*
'Bridging the practice / theory gap?'	Overall many participants considered the impact of the of the dermatology SAFMEDS method on their learning in the clinical teaching setting	*"Helped me recognise some of the rashes/lesions in clinic more easily."* *"If I were to see a different presentation of the same condition I might not recognise it as quickly."*

Table 3. Results of thematic analysis of free-text comments regarding the use of dermatology SAFMEDS flashcard Precision Teaching method

Discussion

This study aimed to determine the impact of PT on medical students' dermatological diagnostic and descriptive skills. Our results clearly indicate that a PT intervention had a positive impact on learners' ability to describe and diagnose a range of important skin conditions, albeit we did not assess long-term effectiveness. The improvements in the intervention group went beyond learning gained due to traditional dermatology teaching methods. Such findings complement and support the increasing use of PT in healthcare profession education (Lydon, et al., 2017).

Unlocking new dermatology educational methods?

At a time when undergraduate dermatology education faces many challenges, novel teaching methods are welcomed (Aldridge, Maxwell, & Rees, 2012; Chiang, Tan, Chiang, Burge, Griffiths, & Verbov, 2011). Though the description and recognition of skin conditions is only one aspect of dermatology education, such skills are fundamental in the practice of dermatology for a wide range of healthcare professionals. Non-analytical skills such as pattern recognition have traditionally been more difficult to teach and precision teaching has the potential to accelerate pattern recognition skills in learners.

Often the drive in medical education is to attain mastery of clinical skills (*i.e. the ability to perform a skill with a high degree of accuracy*). Whilst this is a desirable educational objective, there are challenges when implementing new learned skills into real life settings. Where the mastery of clinical skills is critical, the addition of speed *(i.e. fluency)* can enhance the generalisation of such new behaviours into clinical practice settings. At an individual level, fluent behaviours are more enduring and less susceptible to skill decay and distraction – vital qualities in the complex environments of modern clinical practice.

Precision teaching in dermatology: *A learner-centric training method*

This study tested the hypothesis that PT could enhance the acquisition of fluency in description and recognition of dermatological diagnosis for various skin lesions. Whilst this study did not primarily aim to investigate the general usability and feasibility of this educational method, participants provided a range of important insights about the potential integration of this teaching method into educational practice.

First, the use of SAFMEDS flashcards in repeated 1-minute trials appeared to be a brief but effective teaching method that students could easily integrate into their study habits. Second, by following the PT method, the deliberate repetitive engagement with the picture on the

flash cards enhanced participants' confidence by reinforcing recognition and fluency in the description of skin lesions. Third, in terms of usability, students found that the brief time spent using the cards (i.e. 1 minute at a time) was an optimal use of their time for the educational gain achieved. Furthermore, this educational method was relatively inexpensive, learner-centred (for providing the possibility to detect own progress and practise on errors accordingly) and resource efficient (i.e. no need for a teacher to be present). Such insights are important for the implementation and sustainability of new teaching approaches into dermatology educational practice.

Strengths and limitations

There were a number of strengths to this study. First, we examined a novel training method to the field of dermatology education, at a time where many have called for new approaches to dermatology education. Thus, effective and innovative methods are welcomed. Second, we were able to perform a fully powered controlled study in a valid teaching setting and identify a dose effect (i.e. the more times students used SAFMEDS the higher they performed in the post-teaching assessment test).

However, our findings have to be considered within the limitations of this study. Whilst the medical degree programme at QUB is typical of many UK based medical schools, the results may not be fully generalisable to other institutions. Furthermore, while we are aware from other studies of the transient effect of teaching diagnostic skills (Aldridge, Maxwell, & Rees, 2012), we only investigated the short-term impact of the PT method on medical students' dermatological diagnostic skill development. It was beyond the scope of this study to determine the long-term impact on their dermatological skills. However, the evidence underpinning PT indicates that it can have a positive impact on maintaining new skills in day-day practice.

The translation of PT into individuals' practice is characterised by the acronym REAPS (i.e. a behaviour that is learnt to fluency is **R**etained for a sustained period of time; skills **E**ndure over long durations; skills **A**dapt to new contexts; skills are **P**erformed at a functional rate and performance has **S**tability despite distraction) (Haughton, 1980). We did not assess all the aspects of a full REAPS assessment. Last, we tested participants' skills on their performance of a dermatological image-based test. Performance in such an assessment may not directly translate into real clinical practice.

Implications for practice and future research

The findings from this study signal that this relatively inexpensive teaching method shows promise in complementing other forms of medical student dermatology teaching. This form of learner-centred training may provide dermatology educators with an additional teaching tool that could be easily integrated in a blended-learning approach.

Pattern recognition is increasingly being taught by a variety of methods and relatively brief interventions can produce large learning gains (Kellman, 2013). It has been argued that increased use of online image data bases could remove the reliance on a constant supply of example lesions in clinic (Aldridge, Li, Ballerini, Fisher, & Rees, 2010) and the use of 3D models could enhance teaching further (Aldridge, Li, Ballerini, Fisher, & Rees, 2010; Garg, Haley, Hatem, 2010; Liew, Beveridge, Demetriades, & Hughes, 2015). Dermatologists feeling under threat from *deep neural networks* (Esteva, et al., 2017) should fear not - although pattern recognition can have a powerful influence on diagnosis it should be used alongside analytical processes in the clinical reasoning process (Burge, 2004; Pelaccia, Tardif, Triby, & Charlin, 2011). Traditionally thought as being impractical to teach (Burge, 2004; Sneddon, 1970) we argue that pattern recognition can be developed in students through the use of PT and should be used as an adjunct to compliment traditional teaching methods.

Whilst this research provides a sound theoretical grounding for the introduction of PT as an educational tool, further research needs to be carried out in order to determine its true educational potential in different areas of medical education. For example, the long-term impact of PT-based medical training needs to be investigated. The impact of PT on dermatology education for other healthcare professions (e.g., GP trainees) is also worthy of investigation. Last, the impact of this educational method on the actual diagnosis of patients' dermatological conditions needs to be determined.

CONCLUSIONS

The use of PT in dermatology education shows promise in enhancing medical students' dermatological diagnostic skills. This training tool is learner-centred and allows students to self-guide their dermatological skill development in a timely and resource efficient manner. Dermatology PT has the potential of being integrated with other forms of traditional dermatological teaching methods in a blended fashion. The findings of this study warrant further research to determine the full potential of this educational method in dermatology and other areas of medical education.

Take Home Messages

- Educators have been challenged to provide more effective dermatology teaching methods.

- Developed from the discipline of Applied Behaviour Analysis, Precision Teaching (PT) is an educational method used to develop *behavioural fluency*, i.e. *accuracy* and *speed* in skill performance
- We aimed to determine the impact of PT on medical students' dermatology diagnostic skills compared to traditional teaching methods.
- Our results indicate that PT had a positive impact on learners' ability to describe and diagnose a range of important skin conditions.
- The use of PT in dermatology education shows promise in enhancing medical students' dermatological diagnostic skills.

Notes On Contributors

Dr Conor McGrath is a consultant dermatologist at Craigavon Area Hospital. Interests include medical education, quality improvement and paediatric dermatology.

Dr Collette McCourt is a consultant dermatologist in the Belfast Health & Social Care Trust with a specialist interest in medical dermatology and inflammatory skin disease and undergraduate medical education.

Dr Andrea Corry is a consultant dermatologist at Belfast City Hospital, with two main areas of specialist interest; medical education and skin care in immunocompromised patients. She is also lead for undergraduate dermatology within the centre for medical education, Queens University, Belfast.

Dr Katerina Dounavi is a Psychologist and Board Certified Behavior Analyst-Doctoral (BCBA-D®). She serves as a Lecturer in Behaviour Analysis and Autism and MScABA Director at Queen's University Belfast. She has with extensive experience in supervising behavioural interventions and conducting staff training internationally. Her research interests focus on applied behaviour analysis, developmental delays including autism, evidence-based education, inclusion, and verbal behaviour.

Prof. Karola Dillenburger is a Clinical Psychologist (HCPC) and Board Certified Behavior Analyst-Doctoral (BCBA-D). She is the Director of the Centre for Behaviour Analysis at Queen's University Belfast, where she co-ordinates the MScASD. Her main research focus is on applied behaviour analysis, disability, parenting, and psychological trauma.

Dr Gerard Gormley is a clinical academic General Practitioner at Queens' University Belfast (QUB). He is academic lead for Scholarly and Educational Research Network' (SERN) at QUB. He has a two main streams of research, namely simulation based learning in healthcare and to Objective Structured Clinical Examinations.

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Appendices

Dermatology Precision Teaching Data sheet

Name:	**Hospital site:**

√: correct **X: incorrect** **Total: sum up √ and X**

Date	Try	Score			Date	Try	Score	
		√	X				√	X
17/09/2014	1				17/09/2014	1		
	2					2		
	3					3		
	4					4		
	5					5		
Total					Total			

Date	Try	Score			Date	Try	Score	
		√	X				√	X
17/09/2014	1				17/09/2014	1		
	2					2		
	3					3		
	4					4		
	5					5		
Total					Total			

Date	Try	Score		Date	Try	Score

		√	X				√	X
17/09/2014	1				17/09/2014	1		
	2					2		
	3					3		
	4					4		
	5					5		
Total					Total			

Date	Try	Score			Date	Try	Score	
		√	X				√	X
17/09/2014	1				17/09/2014	1		
	2					2		
	3					3		
	4					4		
	5					5		
Total					Total			

Declaration of Interest

The author has declared that there are no conflicts of interest.